

Materials Technology Training Pilot Program

Program Description

Materials science technicians play an important role in the ability of Los Alamos National Laboratory to fulfill its mission to continue to ensure the safety and reliability of the US nuclear weapons stockpile; to reduce threats to US security; to use science to clean up the legacy of the Cold War; and to provide technical solutions to key energy, environment, infrastructure, and health security problems. The Materials Science Technician Training Program was established to replenish one category of essential technical personnel, materials science technicians, in anticipation of recognized future needs. "Nuclear and Advanced Materials" is recognized as a Laboratory Core Competency, and materials science is a Critical Skills area. The groundbreaking is slated for the summer of 2002 for the new Center for Integrated Nanotechnologies (CINT), one of five centers being established by the Department of Energy, Office of Basic Energy Sciences (DOE/OBES) to form an integrated national program of Nanoscale Science Research Centers (NSRCs) affiliated with major facilities at the DOE's national laboratories. These centers will cover the diverse aspects of nanosciences and will leverage existing DOE facilities. This complex aspires to become a cornerstone of the nation's nanotechnology revolution, contributing to DOE's principal missions in national defense, energy, and the environment while providing an invaluable resource for universities and industries.

Materials science technicians to support these efforts must be recruited, and will be recruited from the region; traditionally, this has always been so. This training program, which offers full-time work at a living wage with benefits, targets a hitherto-untapped pool of working adults who possess valuable skills but who do not wish to, or cannot afford to, attend college on a part-time basis or earn the wages of a student intern. In addition, the education and training included in this program improves retention rates, productivity, efficiency, and flexibility and improves morale of technician trainees. The scientist/

supervisor benefits from a technician who can contribute quickly, and who is engaged in a specialized materials science education, and is not being paid from research funding.

Table 9 shows that materials science technicians are employed in several divisions at the Laboratory. It also shows that there were no technicians, Level 3 (TEC 3) employed at the Laboratory prior to the six participants recently hired in this program. In addition, there are few technicians Level 4 or 5 currently employed at the Laboratory. This dearth of entry-level technicians has

Table 9. Materials Science Technician Statistics—LANL—2001

Division	TEC 4	TEC 5	TEC 6	TEC 7	Total
C			1		1
DX				1	1
EES			1	1	2
ESA		3	3		6
MST	1	5	35	18	59
NMT	2	10	27	7	46
	3	18	67	27	115

serious ramifications regarding career succession planning, the aging work force, knowledge and critical skills transfer, and recruitment and retention issues.

Table 10 lists ages of technicians at the Laboratory. An aging work force is clearly demonstrated by the fact that 73.9 % of materials science technicians and 76.1 % of all technicians regardless of specialty are aged 40 and older.

The main focus of the Materials Science Technician Training Program centers on recognizing future work force needs, proactive planning and implementation of the plan to address perceived shortages, and subsequently ensuring that the Materials Science and Technology Division has the highly-skilled and motivated employees it needs to fulfill the division's and the Laboratory's mission.

It is recognized that students in the region are not exposed to materials science in their elementary or secondary school coursework. Post-secondary education in materials science is needed to produce the specialized technical workers needed at the Laboratory, since currently no such formal training mechanisms or programs exist in northern New Mexico to serve as a pipeline to direct talented and trained individuals toward a career in materials science at the Laboratory. Technicians educated in materials science

fundamentals can more easily, quickly, and efficiently reposition themselves in new areas of research. Successful training program applicants will be high school graduates or possess a general equivalency diploma (GED). The certificate-degree granting program at the Los Alamos branch campus of the University of New Mexico encompasses two years of part-time (9 credit hours per semester) enrollment.

The ultimate goal of this program is to establish and implement at the Laboratory a long-term, strategic, institutionalized Technician Training Program (for all TEC series) on a priority basis for replenishing essential personnel. This training program must address work force development, aging work force, 'pipeline' issues, career succession, maintenance of critical skills, and transfer of knowledge.

Program Description/Design

The Materials Science Technician Training Program includes a certificate-degree-granting program at the University of New Mexico – Los Alamos Branch Campus in addition to employment as a limited-term Materials Technician, Level 3 at Los Alamos National Laboratory. Participants will be employed for two years in the Los Alamos National Laboratory's Materials Science and Technology Division. Technician trainees are assigned to work under the guidance

Table 10. 2001 Technician Ages

Age	MS TEC	All TEC
16-24		9
25-29	3	60
30-34	7	100
35-39	20	209
40-44	15	311
45-49	31	364
50-54	25	299
55-59	13	182
60+	1	49
		115 1583
		73.9% 76.1% 40 and older
		33.9% 33.5% 50 and older

of, and be mentored by, technical staff members and senior materials science technicians and will be assigned to research projects investigating challenging and important technical problems in critical skill areas directly benefiting the DOE/DP mission. It is envisioned that ten technician trainees will be hired every year.

A portion of the technician trainee's workday will be spent at the university attending academic courses specially designed for and directly relating to their job at the Laboratory. The coursework helps program participants develop critical skills that enhance the short-term and long-term productivity and viability of the Laboratory. At this time, there is no formal training in northern New Mexico for materials science technicians; this program addresses this perceived need. The availability of trained, professional technicians is a powerful recruiting tool to attract research scientists to the laboratory. On-the-job training of trainees at an entry-level technician grade (TEC 03) is efficient and low-cost to the Laboratory and provides an excellent dollar return on the investment.

The curriculum includes an introductory course in metals, polymers, and ceramics; an "elements of chemistry" course; and other courses as determined by an advisory council. The inclusion of experienced materials science technicians on the advisory council will ensure that coursework complements and enhances the work experience at the Laboratory. Potential hires will be screened to determine technical aptitude and academic preparedness for the curriculum prior to admittance to the program in order to minimize the possibility of failure. Students will be matched with Laboratory research scientists working on exciting projects. Developing a student-training program in materials technology will require a team effort using the knowledge and expertise of

University of New Mexico staff and instructors as well as Laboratory materials scientists and materials science technicians.

Upon successful completion of the two-year training program, students will be awarded a Certificate in Materials Technology from the University of New Mexico. At that time, continued employment at the Laboratory is a possibility, dependent upon position availability and funding. Students will also have the opportunity to continue their education at the University of New Mexico by earning an associate's or bachelor's degree. Students would also have the option of pursuing a bachelor of science degree in materials science and engineering at the New Mexico Institute of Mining and Technology in Socorro. Each mentor-supervisor will develop a work plan for each student intern. Student interns will be evaluated both in their courses at UNM-LA and in their work by their Laboratory supervisors.

Table 11 shows that over half of Laboratory technicians have no post-secondary school education.

The program participant recruiting strategy includes

- Creating and disseminating a brochure describing the program
- Certificate Degree Program description and curriculum and course listing in the University of New Mexico-Los Alamos branch course catalog
- Descriptive articles in Laboratory publications
- Speaking engagements at local public secondary schools
- Job ad posting at the Laboratory's website

Table 11. All TEC Series: Regular Employees by Highest Degree for TEC Series

None	APP	Assoc	BA/BS	MA/MS	DVM	PhD	Total
841	116	325	245	57	1	7	1592

Performance Objective and Milestones

Performance Objective for 2001: Implement the program and hire participants.

Milestone reached: Participants applied for a job, were matched to a supervisor, and hired.

Milestone reached: Courses were developed, and the Certificate-Degree Program curriculum was developed and approved by the University.

Milestone reached: Six students on schedule to graduate with a Certificate in Materials Science Technology from UNM-LA in June 2003.

Performance Objective for 2002: Institutionalize program at a level higher than division level, so scientists and materials science technicians in the Nuclear Materials Technology (NMT) and ESA Divisions can participate in the program.

Milestone to be achieved: Fund program for ten hires/year at a level higher than division level.

Milestone to be achieved: Hire at least one participant/technician trainee in the Nuclear Materials Technology (NMT) Division.

These performance objectives contribute to the Laboratory's mission to ensure the safety and reliability of the US nuclear weapons stockpile; to reduce threats to US security; to use science to clean up the legacy of the Cold War; and to provide technical solutions to key energy, environment, infrastructure, and health security problems by creating a means to recruit, hire, and retain a highly trained and highly educated work force. These trained materials science technicians directly contribute to ensuring that the Laboratory has a work force that is competently trained in DOE-DP Critical Skills area #4: Materials Science and Technology, which includes

- Specific materials expertise (e.g., Pu, Be)
- High explosives properties study and fundamental modeling

- Compatibility
- Computational materials modeling
- Mechanics of materials
- Materials science measurements
- Surface science
- Organic chemistry
- Metallurgy
- Radiochemistry

Highlights of This Year's Accomplishments

After receiving funding from DOE-DP to create a Materials Science Technician Training Program in late 2000, the Laboratory's Materials Science and Technology Division Director fully funded the Project Director to create and implement a two-year training program that incorporated a Certificate Degree-granting curriculum at the University of New Mexico – Los Alamos branch and an internship with a supervisor/mentor at the Laboratory. The first order of business was three-fold: develop courses at UNM-LA, recruit participants, and recruit Laboratory scientists to be supervisors.

Working with UNM-LA staff, the Certificate Degree Program was developed. All courses except the MST courses were already available on campus. A two-year curriculum was designed to incorporate courses such as chemistry, algebra, and trigonometry, which would provide a foundation for understanding materials science and technology concepts. The two "Introduction to Materials Science" courses set the stage for the four specialty materials science courses, which provide a deeper comprehension of the structure-properties-processing-performance relationships that materials exhibit. The "Materials and Process Selection" course provides an opportunity for Laboratory scientists to task their student-technicians with designing a process or part that is needed in the workplace.

UNM-LA Materials Science Technology Certificate Suggested Cycle

Course Number	Course Name	Credits
Fall Semester (1st)		
Engl 101	-Composition I: Exposition	(3)
MST 101T	-Introduction to Materials Science Technology I	(3)
Math 119	-Algebra	(4)
Spring Semester (1st)		
Math 123	-Trigonometry	(2)
MST 102T	-Introduction to Materials Science Technology II	(3)
Chem 111L	-Elements of General Chemistry	(4)
Fall Semester (2nd)		
CT 102LT	-Introduction to Microcomputers on the PC	(4)
MST 104T	-Introduction to Microscopy and Microstructures	(3)
MST 106T	-Principles of Heat Treating	(3)
Spring Semester (2nd)		
Engl 119T	-Technical Communications	(3)
MST 108T	-Introduction to Mechanical Behavior of Materials	(3)
MST 110T	-Materials and Process Selection	(3)
Summer		
MST 296T	-Materials Science Technology Cooperative Work Phase 1, 2, or 3	(1–3)

UNM-Los Alamos MST Course Descriptions

MST 101T-Introduction to Materials Science Technology I (3)

The course will introduce students to fundamental concepts in materials science and technology. Topics to be covered include atomic bonding, microscopic structure, mechanical deformation, phase diagrams, and processing of metals, ceramics, polymers, and composite materials.

MST 102T-Introduction to Materials Science Technology II (3)

The course will build upon the fundamental concepts in materials science and engineering, as applied to engineering disciplines, and as introduced in Introduction to Materials Science I. Students will learn about the structure of ceramics, polymers, and composite materials and how corrosion resistance and thermal, electrical, magnetic, and optical properties are derived from structure. Students will also learn about materials selection and design considerations, and the economic, environmental, and societal issues in material science and engineering. (Prereq: MST 101T)

MST 104T-Introduction to Microscopy and Microstructures (3)

Metallography is the study of the interrelationship between the structural characteristics and the physical and mechanical properties of metals, alloys and nonmetallic materials such as ceramics, polymers, and composites. Structural interpretation of these materials is made possible by viewing specimens with microscopes, both electron and light. Students will learn to recognize features in the microstructure that give information about processing, mechanical properties and defects, and how to correlate microstructures to manufacturing and heat treat processes. Students will gain some understanding of which features are the true microstructure and which are preparation artifacts.

MST 106T-Principles of Heat Treating (3)

This introductory course will address the purpose of, and various types of heat treatment. The types of furnaces, and the quenching media used in heat treating will also be discussed. The heat treating of steel, aluminum alloys and titanium alloys will be discussed in detail. (Prereq: Math 119 and Chem 111L)

MST 108T-Introduction to Mechanical Behavior of Materials (3)

This course is designed to introduce the student to the basic mechanical behavior of metals, ceramics, and polymers. The origin of mechanical properties in engineering materials is discussed from a fundamental viewpoint and the concepts are used to explain how various methods used to strengthen materials actually work. Properties such as tensile strength, ductility, elastic modulus, hardness, fatigue life, and toughness are covered in this seminar. (Prereq: Math 123)

MST 110T-Materials & Process Selection (3)

Students will use the knowledge gained in previous materials science courses to solve a materials-related design problem. Students will be asked to search the literature, select materials and processes needed to design a part, a machine, or a process, and present oral and written reports.

Course content and lecture materials for MST 101T and MST 102T are based on those developed for the MSE 205 course offered at The Ohio State University's Materials Science and Engineering (MSE) Department. Lectures are based on an interactive PowerPoint slide show. Students are provided with color copies of all slides prior to the class lecture; thus, students are able to interact more easily and completely with the lecturer because the need to take notes is not overwhelming. Ten copies of the textbook *Materials Science and Engineering An Introduction*, fifth edition, by William D. Callister, Jr. and the CD-ROM *IMSE: Interactive Materials Science and Engineering*, third edition were donated by the publisher, John Wiley and Sons, Inc. Each student was given a copy of the CD-ROM. Animations and 3-D projections allowed the students to visualize processes and concepts that are sometimes difficult to understand.

Two of the advanced materials courses will be developed as on-line courses. Currently, a proposal has been made to the NSF for funds to achieve this goal. Notification of success or failure should occur within the next few months. Following is a project summary of the proposal. If funding is not awarded, the courses will be taught using ASM International videos and self-study materials.

Materials Science and Technology Online

Project Summary

To meet the materials science training and curriculum requirements of community college students and instructors, we propose to develop a model for a certificate and Associate of Technical Arts degree (ATA) program in Materials Science and Technology (MST) that takes advantage of online course delivery to reach students nationwide. The model will be developed and tested at Edmonds Community College (EdCC) and the University of New Mexico–Los Alamos Branch (UNM-LA). Through a workshop held at the end of the project, invited community colleges will be encouraged to offer online materials science and technology courses to establish a national distributed certificate and degree program.

To achieve the goals of this project, efforts will be focused in three main areas:

- Survey industry and educational institutions to determine the course requirements for a Materials Science and Technology Certificate and ATA degree
- Develop, test, and evaluate two online materials science and technology courses to determine the feasibility and practicality of

distance learning for technology students

- Obtain potential academic partners to establish a national network of materials science and technology online courses.

ASM International will provide assistance in establishing the course requirements and in course development. ASM International, a professional materials society, currently offers through their Materials Engineering Institute over 75 materials science and technology training courses available in face-to-face seminar, self-study, and videotape formats. Edmonds Community College has one of the largest distance learning programs in Washington state and has consistently been a leader in the implementation of distance-delivered courses. By combining ASM International's expertise in materials science and technology curriculum with Edmonds Community College's expertise in online course delivery, community colleges and industry would greatly benefit. University of New Mexico-Los Alamos Branch expertise gained from developing their Materials Science Technology Certificate program will be used as the basis for the online certificate and degree programs.

The online courses will also provide materials science and technology training to current and new technicians in industry and professionals who need to be updated on changes in advanced materials science and technology. The online courses can also be used in various state job training and certification programs. The feasibility and practicality of distance learning for community college students in engineering and technology will be established. Issues such as hands-on activities for online technical courses will be addressed, and alternatives to on-site laboratory classes will be investigated.

Nine students were recruited and enrolled in the Introduction to Materials Science course in August, 2001. Six students successfully completed the course in December 2001. During the

summer of 2001, information about the technician training program was disseminated both formally at student orientations at UNM and in Laboratory news publications, and informally through personal e-mailings and word of mouth. Recruitment of scientist supervisor/mentors was accomplished through MST Division mailings and personal phone calls. The project director has eight years experience working as a materials science researcher in the division, and thus has many personal and professional contacts.

Los Alamos National Laboratory Job Ad 028088 was posted to formally hire ten limited-term Materials Science Technicians, Level 3, at a salary of \$30,000 per year. The job ad was open for ten days and resulted in 96 applicants, of whom 22 have been interviewed. At this time, the six program participants enrolled in the UNM-LA Certificate Program have been matched with a supervisor in the MST Division, hired, and have started work in their respective laboratories.

Examples of the type of research work that the technicians will be involved with:

- basic research in an ultrafast-laser laboratory on a number of unique materials, particularly those with novel superconducting, magnetic, and dielectric behavior
- materials synthesis and characterization basic research in the Magnetic Resonance Force Microscopy Laboratory, where a new scanning probe technique based on mechanical detection of magnetic resonance is being developed
- development of fuel cell components, stacks and systems
- basic research into thermoacoustic phenomena
- work with the welding, metallography, metal fabrication, and powder metallurgy teams on various research projects in the Metallurgy Group